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(54) Fuel container with integrated impurity removal cartridge, sulfur removal cartridge and method of reducing filter maintenance and making such a cartridge

(57) A fuel supply for a fuel cell including a fuel container (210) and an impurity removal cartridge (230) connected to the fuel container (210), where both the fuel container (210) and the impurity removal cartridge (230) are integrated into a single unit.

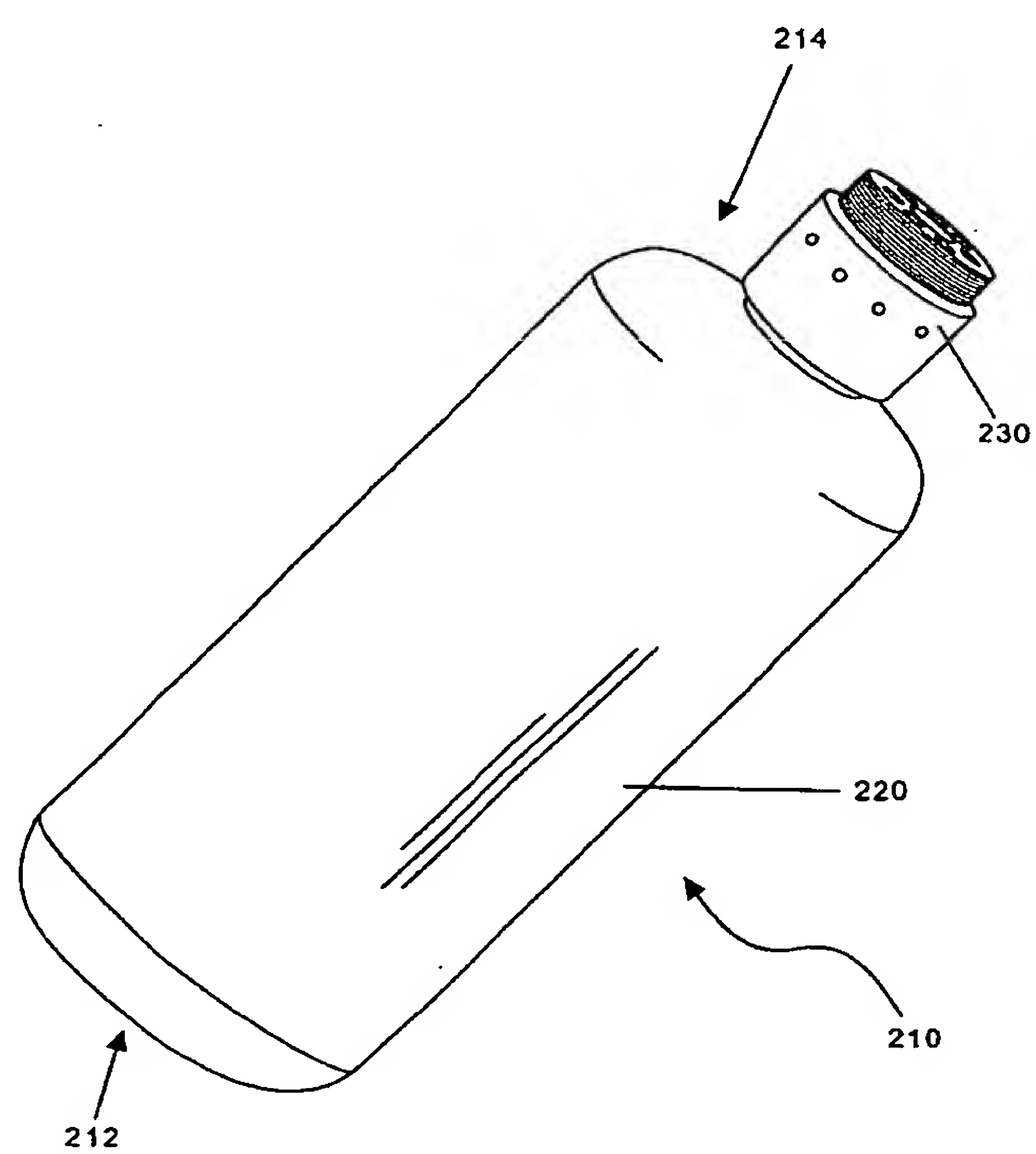

FIG. 2

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Description

BACKGROUND

[0001] During the past several years, the popularity and viability of fuel cells for producing large and small amounts of electricity has increased significantly. Fuel cells conduct an electrochemical reaction with chemicals such as hydrogen and oxygen to produce electricity and heat. Fuel cells are similar to batteries, but fuel cells can be "recharged" while providing power and are much cooler and cleaner than devices that combust hydrocarbons. Fuel cells provide a DC (direct current) voltage that may be used to power motors, lights, computers, or any number of electrical appliances. There are several different types of fuel cells, each using a different chemistry. Fuel cells are usually classified by the type of electrolyte used. The fuel cell types are generally categorized into one of five groups: proton exchange membrane (PEM) fuel cells, alkaline fuel cells (AFC), phosphoric-acid fuel cells (PAFC), solid oxide fuel cells (SOFC), and molten carbonate fuel cells (MCFC).

[0002] Each of the fuel cells mentioned above uses oxygen and hydrogen to produce electricity. Ambient air typically supplies the oxygen for a fuel cell. In fact, for the PEM fuel cell, ordinary air may be pumped directly into the cathode of the fuel cell. However, hydrogen is not as readily available as oxygen. Hydrogen is difficult to generate, store, and distribute for a number of reasons and is generally handled with appropriate precautions to reduce potential safety hazards.

[0003] One common method for producing hydrogen for fuel cells is through the use of a reformer. A reformer is fed hydrocarbons or other fuels from which hydrogen is produced. The hydrogen produced by the reformer can then be fed to a fuel cell and processed with oxygen to produce the desired electricity. The use of a reformer allows for the production of hydrogen from propane, butane, or a number of other readily accessible natural gases that serve as the hydrogen fuel source.

[0004] Since many common hydrocarbon gases are not readily detectible by human senses, odorizing agents such as sulfur are typically included with the hydrocarbons as a safety feature. If a leak of the hydrocarbons occurs, the leak may be readily detected by smelling the odorizing agent. In some instances, sulfur can occur as a natural constituent of the gaseous fuels. However, many consumer grade hydrocarbons produce undesirable byproducts such as SO_x and NO_x. These by-products are not only pollutants but may also damage the reformer of a fuel cell system. Sulfur, in particular, must be removed from the fuel being fed to the reformer or damage may occur to the electrode catalyst.

[0005] One possible solution to prevent sulfur from reaching the reformer and subsequently the electrode catalyst is to use deodorized fuels as the hydrogen source. However, by deodorizing the fuels used to generate hydrogen, it becomes impossible to smell a fuel leak. If a leak goes undetected because it is imperceptible, the hazards and potential damage that may be caused by the leak are greatly increased. This would likely result in additional shipping, storage, and usage restrictions on the fuel, thereby increasing the fuel cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The accompanying drawings illustrate various embodiments of the present invention and are a part of the specification. The illustrated embodiments are merely examples of the present invention and do not limit the scope of the invention.

[0007] **Fig. 1** illustrates a prior art system for removing sulfur from hydrocarbon fuels.

[0008] **Fig. 2** illustrates an integrated fuel container and sulfur removal cartridge according to one embodiment of the present invention.

[0009] **Fig. 3** illustrates internal components of an integrated fuel container system and sulfur removal cartridge according to one embodiment of the present invention.

[0010] **Fig. 4** illustrates a sulfur removal cartridge according to one embodiment of the present invention.

[0011] **Fig. 5** is a cross-sectional view of a sulfur removal cartridge according to one embodiment of the present invention.

[0012] **Fig. 6** illustrates the proper flow of a hydrocarbon gas according to one embodiment of the present invention.

[0013] **Fig. 7** illustrates possible system leak sources according to one embodiment of the present invention.

[0014] Throughout the drawings, identical reference numbers designate similar, but not necessarily identical, elements.

DETAILED DESCRIPTION

[0015] An apparatus for integrating a fuel cell fuel supply and a fuel supply cleaner is described herein. According to one exemplary implementation, described more fully below, a fuel supply and an impurity removal cartridge are integrated such that they may both be removed from a fuel cell system as a single functional unit while continuing to provide odor-enhanced leak detection.

[0016] In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without these specific details. Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearance of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same

embodiment.

[0017] An alternative solution to eliminating the sulfur that reaches the reformer is illustrated in Figure 1. As shown in Figure 1, a fuel cell (100) receives fuel from a fuel source (110). Typically, the fuel source (110) supplies consumer grade hydrocarbons such as propane or butane as fuel (112). The consumer grade hydrocarbons typically include an odorizing agent for the safety reasons mentioned above. Prior to entering the reformer (118), the consumer grade fuel (112) passes through an in-line filter (114) or other form of sulfur scrubber physically located just prior to the reformer (118).

[0018] Once the sulfur passes through the filter (114), it exits as deodorized fuel (116). The deodorized fuel (116) may then be fed into and processed by the reformer (118) to produce hydrogen (120). The resulting hydrogen (120) may then be mixed with oxygen (124) in the fuel cell (130) to generate and supply electricity to an electrical load (160) such as a motor or a light. In some embodiments, a capacitor or battery may be connected in parallel with the fuel cell and electrical load to provide power to the load (160) when the fuel cell (130) is starting up or inoperative.

[0019] By deodorizing the fuel (116) prior to its introduction to the reformer (118), the likelihood of damage caused by sulfur and other unwanted pollutants is greatly reduced. However, the in-line filter (114) that is placed in line with the flow of the hydrocarbon fuel (112) typically requires frequent maintenance and/or removal. This continual need for maintenance of the sulfur scrubbing in-line filter (114) is an inconvenience to users.

Exemplary Structure

[0020] Figure 2 illustrates an embodiment of a fuel source capable of providing fuel to, for example, a fuel cell. As shown in Figure 2, one embodiment of the fuel source may include both a fuel container (210) and an impurity removal cartridge (230), e.g., an odorant removal cartridge (230) for an odorant such as sulfur. The fuel container (210) may either be integrally formed with the cartridge (230), or both the fuel container (210) and the cartridge (230) may be formed separately and later coupled.

[0021] The fuel container (210) of the embodiment illustrated in Figure 2 may be a cylindrically shaped fuel container (210) that contains pressurized hydrocarbons, such as propane or butane, and an odorizing agent, such as sulfur. The fuel container (210) may be formed with a body (220) having a distal end (212) and a proximal end (214). If the container (210) and the impurity removal cartridge (230) are formed as separate units, the proximal end (214) of the fuel container (210) includes a means for fluidly coupling the fuel container (210) to the impurity removal cartridge (230), a fuel cell, or any other device that may be fluidly coupled to a fuel source.

[0022] Figure 2 shows the impurity removal cartridge (230) fluidly coupled to the proximal end (214) of the fuel container (210) according to one embodiment of the fuel source. The fuel container (210) may be fluidly coupled to the impurity removal cartridge (230) using any number of coupling means including, but in no way limited to threads, adhesive, clamps or other mechanical devices.

[0023] Figure 3 further illustrates the components of the integrated fuel supply and fuel supply cleaner. As shown in Figure 3, the fuel container (210) includes an internal cavity (225) for storing pressurized fuel until it is released into a fuel-using system. The proximal end (214) of the fuel container (210) further includes a coupling device (280) and a valve (250). The valve (250) forms a portion of the coupling device (280) of the fuel container (210). The valve (250) of the fuel container (210) is used to regulate the release of pressurized fuel from the fuel container (210) into a fuel-using system.

[0024] The valve (250) illustrated in Figure 3 is a Schrader style valve, however, any valve for regulating the emission of pressurized fuels may be used in the present fuel supply. The coupling device (280) illustrated in Figure 3 is an externally threaded segment located on the proximal end (214) of the fuel container (210). The coupling device (280) may couple the fuel container (210) to the impurity removal cartridge (230) and subsequently to the rest of the system. While the present fuel supply (210) is shown using threads as the means for coupling the fuel container (210) and the impurity removal cartridge (230) to the system, other coupling means may be used.

[0025] Figure 3 also illustrates the internal components of one embodiment of the impurity removal cartridge (230). As shown in Figure 3, the impurity removal cartridge (230) includes an actuator orifice (260) located along the center axis of the body of the impurity removal cartridge (230). The impurity removal cartridge (230) also includes a sulfur removing adsorbent (240) that is substantially contained within the body of the impurity removal cartridge (230).

[0026] A number of radially routed orifices (270) are also located on the body of the impurity removal cartridge (230) just below the sulfur removing absorbent (240). The radially routed orifices (270) extend radially from the center of the body of the impurity removal cartridge (230) to the outer surface of the impurity removal cartridge (230) providing a fluid communication channel to the outer surface of the impurity removal cartridge (230).

[0027] Figure 4 is a view of an impurity removal cartridge (230) according to one embodiment of the integrated fuel supply and fuel supply cleaner. As shown in Figure 4, the impurity removal cartridge (230) includes a cylindrically shaped body with both a distal end (470) and a proximal end (460).

[0028] The proximal end (460) is a substantially flat surface with an actuator orifice (260) formed at the center. The actuator orifice (260) extends the entire length

of the impurity removal cartridge body (230) along the center axis. The actuator orifice (260) receives an actuator when the impurity removal cartridge and fuel container are coupled to a fuel-using system and provides a leak detection channel when in storage.

[0029] A number of external axially routed orifices (425) are also located on the face of the proximal end (460), which extend axially into the body of the impurity removal cartridge (230). These external axially routed orifices (425) may have a circular cross section and extend only a short distance into the body of the impurity removal cartridge (230). The external axial routing orifices (425) provide for the flow of any fuel that has passed through the body of the impurity removal cartridge (230).

[0030] Figure 4 also illustrates external threads (420) located on the outer surface of the proximal end (460) of the impurity removal cartridge body (230). The external threads (420) are included as part of the impurity removal cartridge (230) to allow the impurity removal cartridge (230) to be fluidly coupled to a fuel cell or other fuel-using system. Any coupling means may be used that are capable of providing fluid communication to couple the impurity removal cartridge (230) to a fuel-using system.

[0031] On the distal end (470) of the impurity removal cartridge (230), immediately adjacent to the external threads (420), is a lip (415). The lip (415) provides a stopping surface for any coupling device that is fluidly coupled to the impurity removal cartridge (230) using the external threads (420). Between the distal end (470) of the cartridge (230) and the lip (415), there are a number of radially routed orifices (270) that extend from the center of the impurity removal cartridge (230) to the outer surface of the cartridge (230) and provide a fluid communication channel. While the present embodiment of the impurity removal cartridge (230) has been explained as having a cylindrical body shape, it is possible for the impurity removal cartridge (230) to be any shape capable of being received by the coupler of a fuel-using system. Moreover, the impurity removal cartridge (230) may be constructed of plastic, metal, ceramic, composite, any combination thereof or similar materials.

[0032] Figure 5 is a cross sectional view of one embodiment of an impurity removal cartridge (230) illustrating the structural components of the impurity removal cartridge (230). As shown in Figure 5, the distal end (470) of the impurity removal cartridge (230) includes a receiver cavity (430) for receiving the coupling means of a fuel container (280; Fig. 3) or other fuel supply. Included in the receiver cavity (430) is a means for receiving and fluidly coupling the impurity removal cartridge (230) to the fuel container (210; Fig. 3).

[0033] The coupling means shown in Figure 5 is a series of threads formed on the inner wall of the receiver cavity (430). However, the coupling means of the receiver cavity (430) may be any coupling means capable of fluidly coupling the impurity removal cartridge (230) to a fuel container (210; Fig. 3). On the proximal end of the receiver cavity (430) is one or more radially routed orifices (270) that radially extend from the inner wall of the impurity removal cartridge (230) to the outer wall of the impurity removal cartridge (230). The radially routed orifices (270) provide a fluid communication channel for any pressurized fuels that enter the receiver cavity (430) to the outer wall of the impurity removal cartridge (230). The function of the radially routed orifices (270) is further explained below.

[0034] Perpendicular to the radially routed orifices (270) are a number of internal axially routing orifices (440) that are also in fluid communication with any pressurized fuels that enter the receiver cavity (430). The internal axially routing orifices (440) are fluidly coupled to a fitter-containing cavity (450) as shown in Figure 5. The filter-containing cavity (450) shown in Figure 5 is fluidly coupled to both the inner (440) and outer (425) axial routing orifices providing a fuel flow path from the receiver cavity (430) to a fuel-using system. A fuel-filtering material (240), such as a sulfur removing adsorbent, is substantially contained within the filter-containing cavity (450).

[0035] The fuel-filtering material (240) contained within the filter-containing cavity (450) removes sulfur or any other odorizing agent from pressurized fuel. The fuel-filtering material (240) may be a porous matrix material. Specifically, the fuel-filtering material (240) may be, but is in no way limited to, a zeolite-based filter, calcium-based adsorbents, zinc oxide, activated carbon, or any other wet or dry filter capable of removing odorizing agents from fuel. The sulfur removing adsorbent of the present integrated fuel supply and fuel supply cleaner may be a zeolite-based filter. Zeolites are highly crystalline alumino-silicate frameworks that form a highly crystalline, microporous adsorbent. The zeolites have an internal structure that may be easily tailored to adsorb any number of odorizing agents. The pore size distribution of the zeolites may be modified, enabling the zeolite to be used as a so-called molecular sieve. Molecules that are too large to diffuse into the pores, such as odorizing agents, are excluded while molecules that have a kinetic diameter smaller than the pore size diffuse into the pores and are able to pass through without the larger odorizing agents.

[0036] Figure 6 illustrates how the fuel container (210) and the impurity removal cartridge (230) are fluidly coupled to each other and to a fuel-using system. Beginning with the fuel container (210), the proximal end (214) of the fuel container (210) is fluidly coupled to the distal end of the impurity removal cartridge (230). As shown in Figure 6, the coupling device of the fuel container (210) is inserted and coupled to the receiver cavity (430; Fig. 5) of the impurity removal cartridge (230).

[0037] While the coupling means illustrated in Figure 6 is a threaded system, any fluid coupling means is within the scope of the present system.

The fluid system coupler (600) is then fluidly coupled to

the proximal end of the impurity removal cartridge (230). The fluid system coupler (600) illustrated in Figure 6 is consistent with fluid system couplers known and used in the industry. As shown in Figure 6, the fluid system coupler (600) includes a body with a distal and a proximal end. The distal end of the fluid system coupler (600) includes a reception orifice that protrudes axially into the body of the fluid system coupler (600) and is large enough to receive the body of the impurity removal cartridge (230). The distal end of the fluid system coupler (600) may be coupled to the proximal end of the impurity removal cartridge (230) by a threaded or any other type of coupling system.

[0038] A valve actuator (610) is formed along the center axis of the fluid system coupler (600) body to engage the valve (250) of the fuel container (210). The fluid system coupler (600) also includes a number of fuel flow path orifices (650) on each side of the valve actuator (610). The fuel flow path orifices (650) receive any fuel that has passed through the fuel-filtering material (240) of the impurity removal cartridge (230) and introduce the fuel into the fuel-using system.

[0039] A number of o-rings (620, 625, 630, 635) also form a part of the fluid system coupler (600). The two inner o-rings (625, 635) are located on the valve actuator (610) as illustrated in Figure 6. When the fluid system coupler (600) is coupled to the impurity removal cartridge (230) the inner o-rings (625, 635) form a fluid seal between the valve actuator (610) and the wall of the actuator orifice (260; Fig. 5) of the impurity removal cartridge (230). The seal formed by the inner o-rings (625, 635) prevents any unfiltered fuel from passing through the actuator orifice (260; Fig. 5) of the impurity removal cartridge (230) and onto the fuel-using system without first passing through the fuel-filtering material (240).

[0040] Two outer o-rings (620, 630) are located along the outer wall of the reception orifice of the fluid system coupler (600) as shown in Figure 6. When the fluid system coupler (600) is properly coupled with the impurity removal cartridge (230), a first outer o-ring (630) is located above the radially routed orifices (270; Fig. 5) and a second outer o-ring (620) is located below the radially routed orifices. By securing the outer o-rings (620, 630) both above and below the radially routed orifices (270; Fig. 5) of the impurity removal cartridge (230), a fluidly sealed cavity containing pressurized fuel and odorizing agents is formed when fuel flows through the fuel flow path. This fluidly sealed cavity containing both pressurized fuel and odorizing agents allows the illustrated embodiment to provide external leak detection leveraging the current standard odorizing agents used in the industry prior to their removal by the impurity removal cartridge (230).

Exemplary Implementation and Operation

[0041] Figure 6 illustrates the proper operation of one exemplary embodiment of an impurity removal cartridge (230) when properly connected to a fuel-using system. As shown in Figure 6, pressurized fuel and odorizing agents are contained within the internal cavity (225) of the fuel container (210). When the impurity removal cartridge (230) is coupled to the fuel container (210), the valve (250) of the fuel container (210) is not compressed, but a fluid tight seal is formed between the impurity removal cartridge (230) and the fuel container (210). The fuel container (210) and the impurity removal cartridge may be coupled and stored together for large periods of time without leaking fuel. If a fuel leak does occur during storage or before the fuel container (210) and the impurity removal cartridge (230) are properly connected to a fuel-using system, the leaking gas will enter the atmosphere through either the radially routed orifices (270; Fig. 5) or the unobstructed actuator orifice (260; Fig. 5) of the impurity removal cartridge (230). When fuel escapes the unconnected fuel container (210) and the impurity removal cartridge (230) through the radially routed orifices or the actuator orifice, the fuel is unfiltered and can thus be easily detected by its odor.

[0042] Once the fuel container (210) is properly coupled to the impurity removal cartridge (230), the impurity removal cartridge (230) may also be coupled to the fluid system coupler (600) and subsequently to a fuel-using system. When properly coupled, the valve actuator (610) of the fluid system coupler (600) extends through the actuator orifice (260; Fig. 5) and compresses the valve (250) of the fuel container (210). Once the valve (250) of the fuel container (210) is compressed, the pressurized fuel contained in the fuel container (210) is allowed to escape. As illustrated by the fuel flow arrow in Figure 6, the pressurized fuel passes through the valve (250) of the fuel container (210) and into the impurity removal cartridge (230).

[0043] The pressurized fuel will then fill the cavity created between the fuel container (210) and the impurity removal cartridge (230) including the radially routed orifices (270; Fig. 5). During proper operation of the system, the outer o-rings (620, 630) prevent any pressurized fuel from escaping the system without being filtered. The pressurized fuel also passes through the internal axial routing orifice (440; Fig. 5) and into the filter-containing cavity (450; Fig. 5), both of which form a part of the impurity removal cartridge (230).

[0044] Once in the filter-containing cavity (450; Fig. 5), the pressurized fuel will come in contact with and pass through the fuel-filtering material (240). As the pressurized fuel passes through the fuel-filtering material (240), any odorizing agent or other impurity that is mixed with the pressurized fuel is removed. After passing through the fuel-filtering material (240), the now deodorized fuel passes through the external axial routing orifice (425; Fig. 5) and into the fuel flow path orifice (650) of the fluid system coupler (600). From the fuel flow path orifice (650), the deodorized fuel is introduced into the fuel-using system and may be further processed without damaging the system.

[0045] Figure 7 illustrates possible leak sources of one embodiment of the integrated fuel supply and fuel supply cleaner system. In order to test the integrity of the fluid coupling of the fluid system coupler (600), pressurized fuel is allowed to reach the outer o-rings (620, 630) through the radial orifices (270; Fig. 5) of the impurity removal cartridge (230). If the fluid system coupler (600) does not properly seal around the impurity removal cartridge (230), pressurized fuel that has passed through the radial orifices (270; Fig. 5) may escape through the second outer o-ring (620) to the atmosphere. This leakage to the atmosphere may pose a severe fire and/or explosion hazard. The radial orifices (270; Fig. 5) are formed prior to the fuel-filtering material (240) so that any pressurized fuel that is allowed to reach the second outer o-ring (620) still contains odorizing agents. This embodiment of the impurity removal cartridge (230) allows for the detection of an external fuel leak through scent recognition of a user while still providing deodorized fuel to the system.

[0046] Once the fuel supply in the fuel container (210) has been exhausted, a user may remove both the fuel container (210) and the impurity removal cartridge (230) simultaneously as a single unit by de-coupling the fluid system coupler (600) from the impurity removal cartridge (230). Both the fuel container (210) and the impurity removal cartridge may then be replaced with both a new fuel container (210) and a new impurity removal cartridge (230).

This embodiment of the integrated fuel supply allows the change out frequency of the impurity removal cartridge (230) to be the same as the life of the fuel container (210) thereby freeing the user from changing out both an in-line sulfur filter and the fuel cartridge at different times.

Alternative Embodiment

[0047] Referring again to Figure 7, there are additional possible leakage channels that may allow odorized fuel to bypass the impurity removal cartridge (230) and enter the system fuel stream. As shown by the fuel flow arrows in Figure 7, odorized fuel may leak past the first outer o-ring (630) or both of the inner o-rings (625, 635) and into the system fuel stream without passing through the fuel-filtering material (240). In order to prevent the further leakage of odorized fuel into the system fuel stream, additional o-rings may be placed on various locations of the system coupler. The inclusion of additional o-rings or other sealing means will reduce the likelihood of odorized fuel leaking past the impurity removal cartridge (230).

[0048] Moreover, an in-line removable filter may also be placed within the present system as a safeguard against any odorized fuel that bypasses the impurity removal cartridge (230) due to one of the above-mentioned leaks. By placing an inline filter in the fuel path of the system, any odorizing agent that has leaked past the impurity removal cartridge (230) will be removed from the fuel prior to reaching the reformer or other system components. While the inline filter will need to be removed periodically, the incorporation of the impurity removal cartridge (230) with the fuel container (210) will greatly reduce the exposure of the inline filter to odorizing agents. As a result, the change out frequency of the inline filter will be greatly reduced. Moreover, the life of the inline filter may be designed to match the product life of the system to which it is incorporated, thereby completely eliminating the need for replacement.

[0049] In conclusion, the present invention, in its various embodiments, simultaneously reduces the maintenance needed by a fuel supply while preserving its safety features. Specifically, the present invention provides an apparatus for integrally connecting a fuel supply container to a fuel supply filter. By integrating the fuel supply container and the fuel supply filter, a user no longer needs to periodically change an in-line filter. Rather, the integrated filter may be removed and replaced each time a new fuel supply is provided. The present invention also allows non-filtered, odorized gas to be present in the system sealing means to provide an odorized source of leak detection.

[0050] The preceding description has been presented only to illustrate and describe embodiments of invention. It is not intended to be exhaustive or to limit the invention to any precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be defined by the following claims.

Claims

1. A fuel supply comprising:

   a fuel container (210); and
   an impurity removal cartridge (230) connected to said fuel container (210),

   wherein both said fuel container (210) and said impurity removal cartridge (230) may be simultaneously replaced as a single unit.

2. The fuel supply of claim 1, wherein said fuel container (210) contains pressurized fuel.

3. The fuel supply of claim 2, wherein said pressurized fuel further comprises a hydrocarbon and an odorizing agent.

4. The fuel supply of claim 3, wherein said odorizing agent comprises a naturally occurring sulfur compound.

5. A sulfur removal cartridge comprising:

   a body with a distal end (212) and a proximal

end (214);
a fuel flow path that extends from said distal end (212) to said proximal end (214);
a first coupler disposed on said distal end (212) of said body for fluidly coupling said sulfur removal cartridge to a fuel supply; and
a fuel-filtering material (240) disposed in said fuel flow path that removes sulfur from fuel in said fuel flow path.

6. The sulfur removal cartridge of claim 5, wherein said first coupler comprises internal threads disposed on said distal end (212) of said sulfur removal cartridge.

7. A fuel cell system comprising:

a fuel cell;
a fuel source;
a fuel flow path between said fuel cell and said fuel source; and
an impurity removal cartridge (230) coupled to said fuel source wherein said fuel source and said impurity removal cartridge (230) are integrated into a single unit, said fuel flow path passing through said impurity removal cartridge (230).

8. An electronic device comprising:

a fuel cell providing power to an electrical load (160);
a fuel source;
a fuel flow path coupling said fuel cell and said fuel source; and
an impurity removal cartridge coupled to said fuel source wherein said fuel source and said impurity removal cartridge (230) are integrated into a single unit, said fuel flow path passing through said impurity removal cartridge (230).

9. A method of reducing filter maintenance in a fuel cell system comprising integrally connecting an impurity removal cartridge (230) to a fuel supply wherein both said fuel supply and said impurity removal cartridge (230) are inserted into and removed from said fuel cell system as a single unit.

10. A method of making an impurity removal cartridge (230) comprising inserting a sulfur removing adsorbent (240) in a filter housing; and coupling said filter housing directly to a fuel source such that exiting fuel from said fuel source passes through said sulfur removing adsorbent (240).

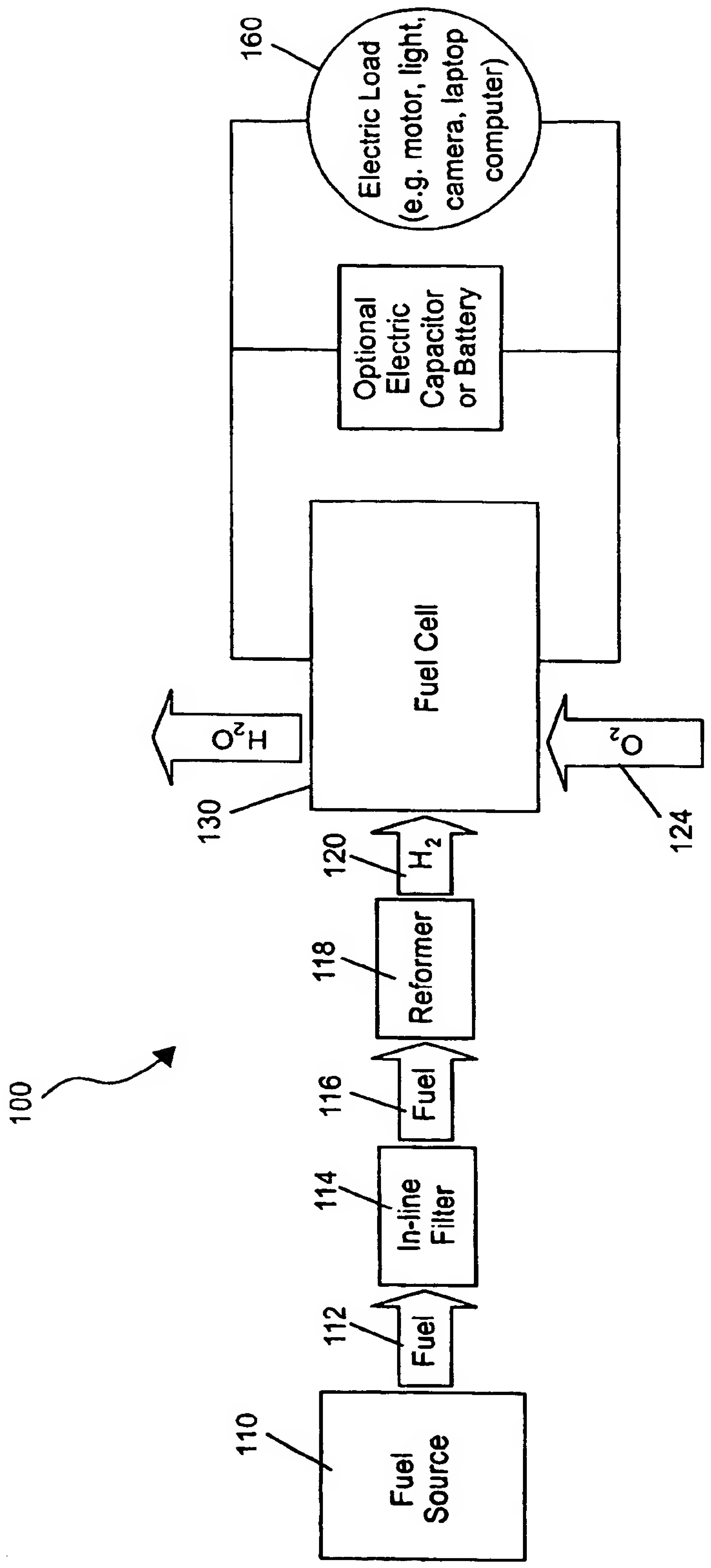

FIG. 1
Prior Art

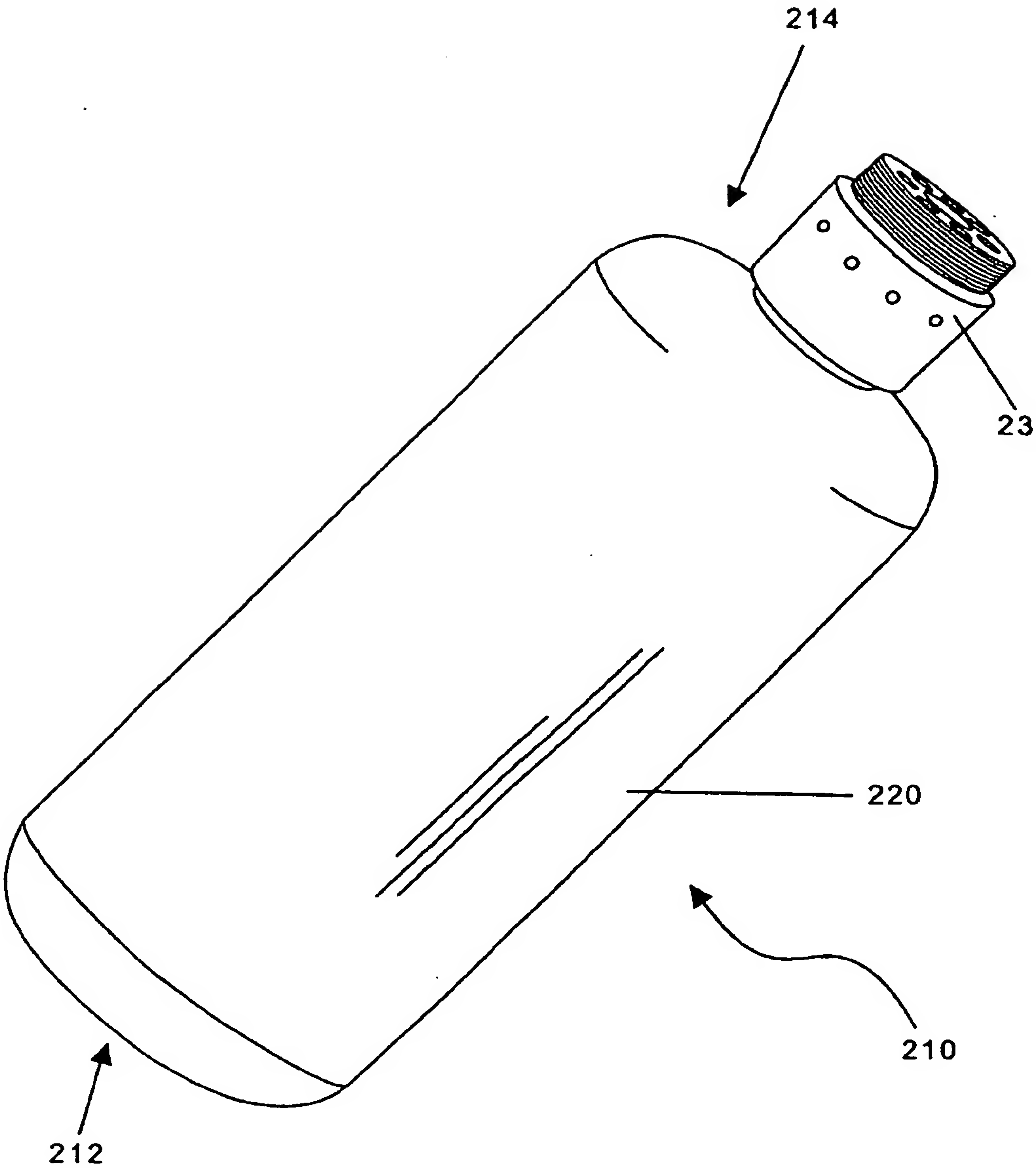

FIG. 2

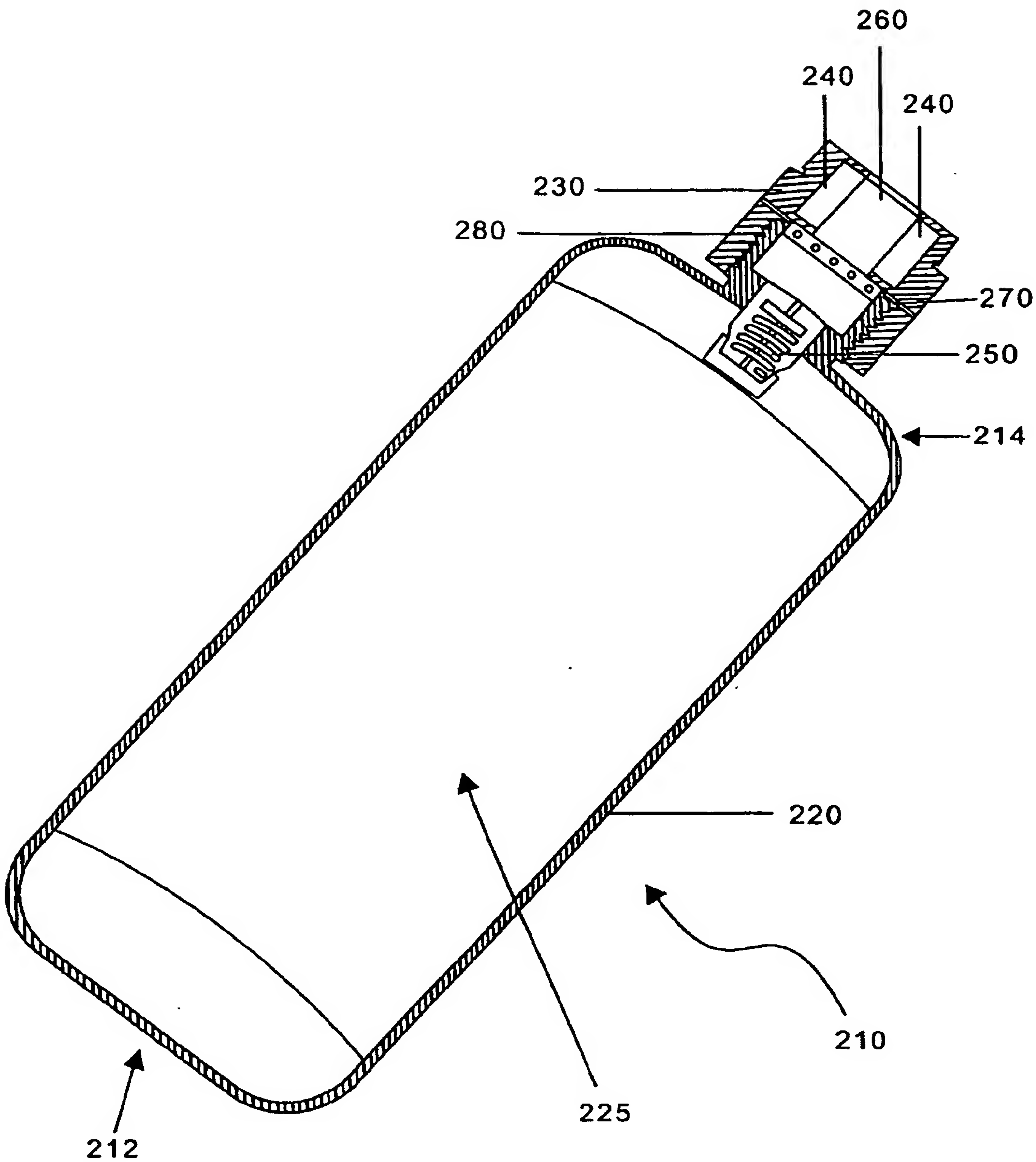

FIG. 3

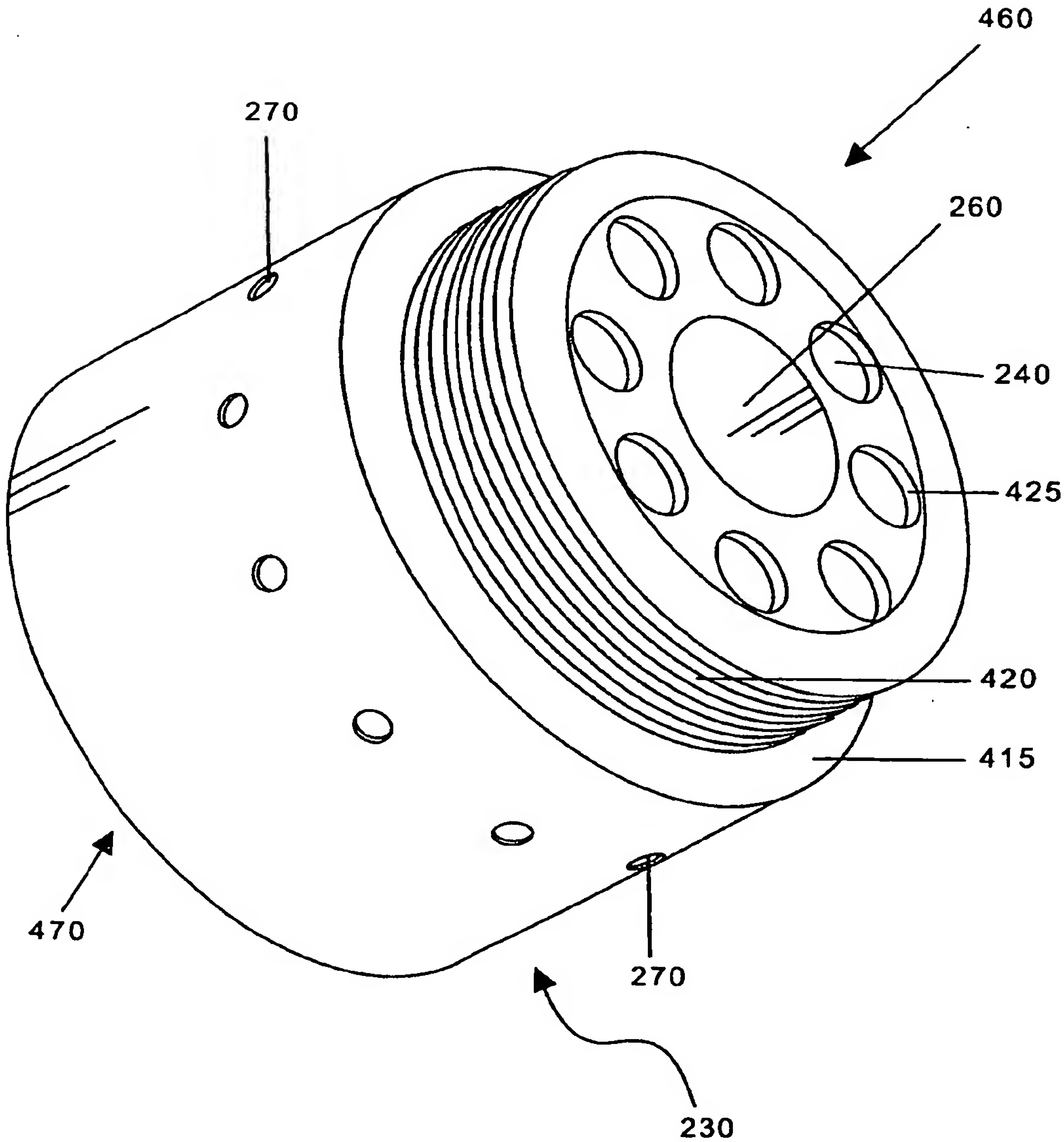

FIG. 4

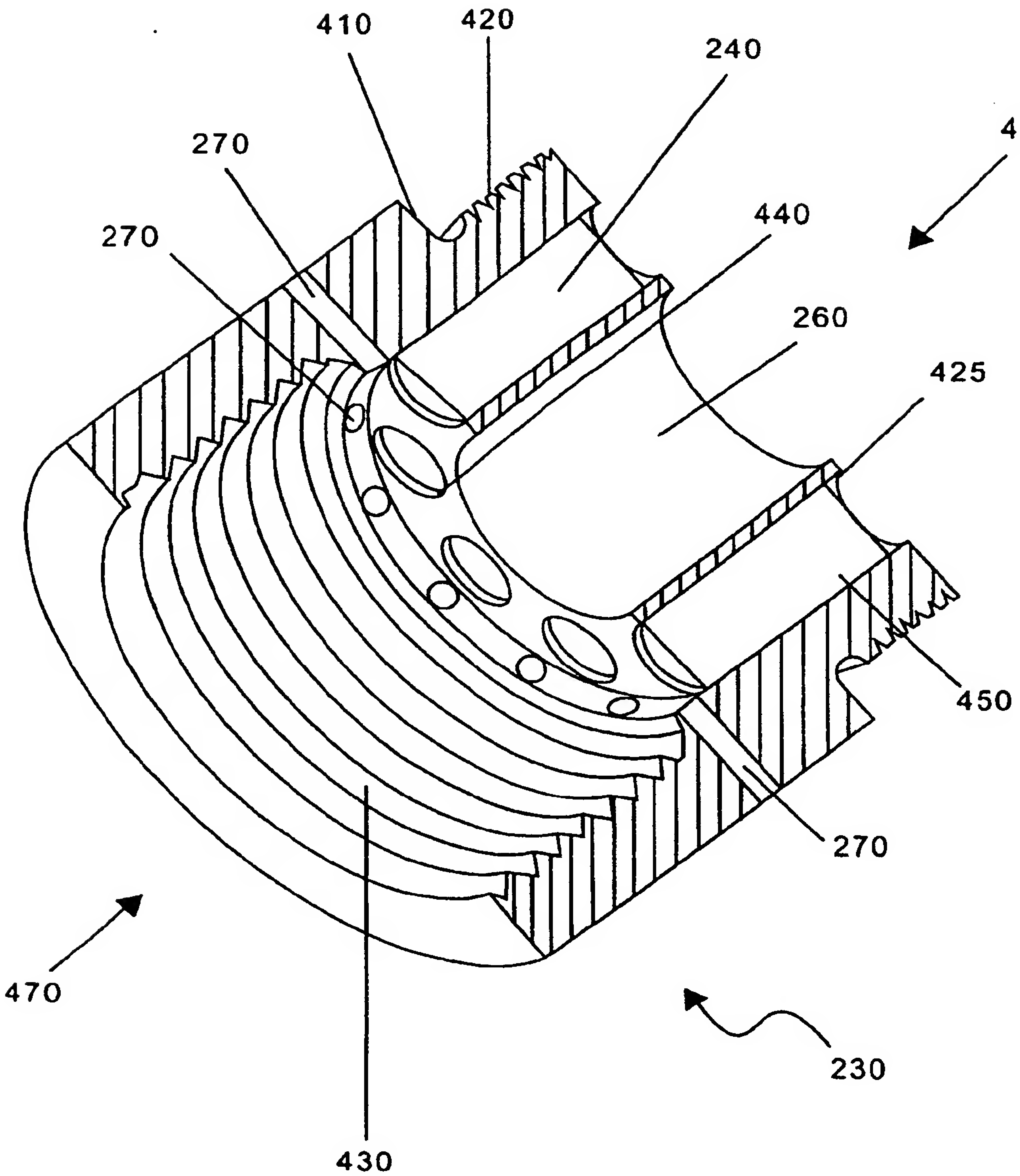

FIG. 5

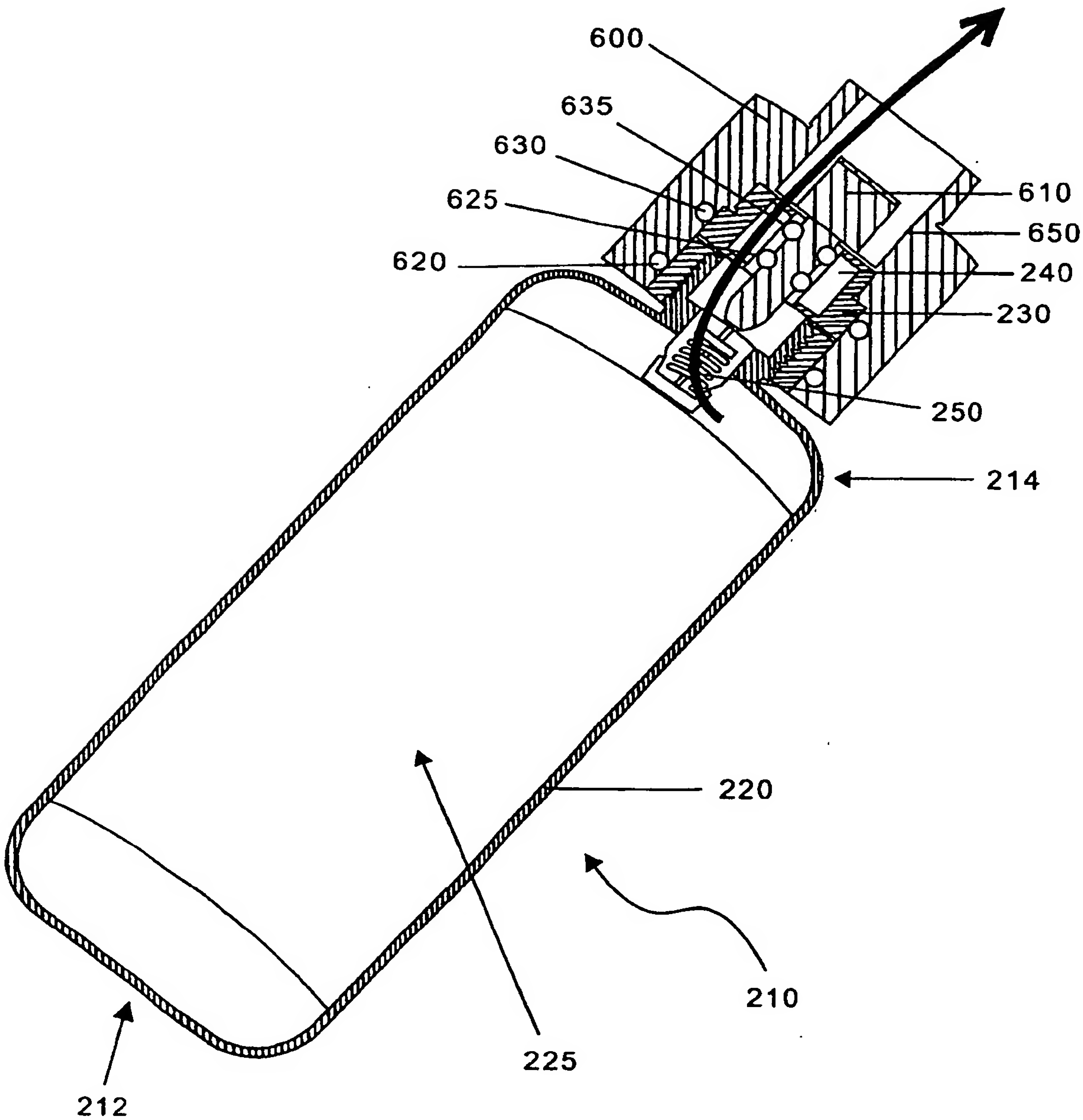

FIG. 6

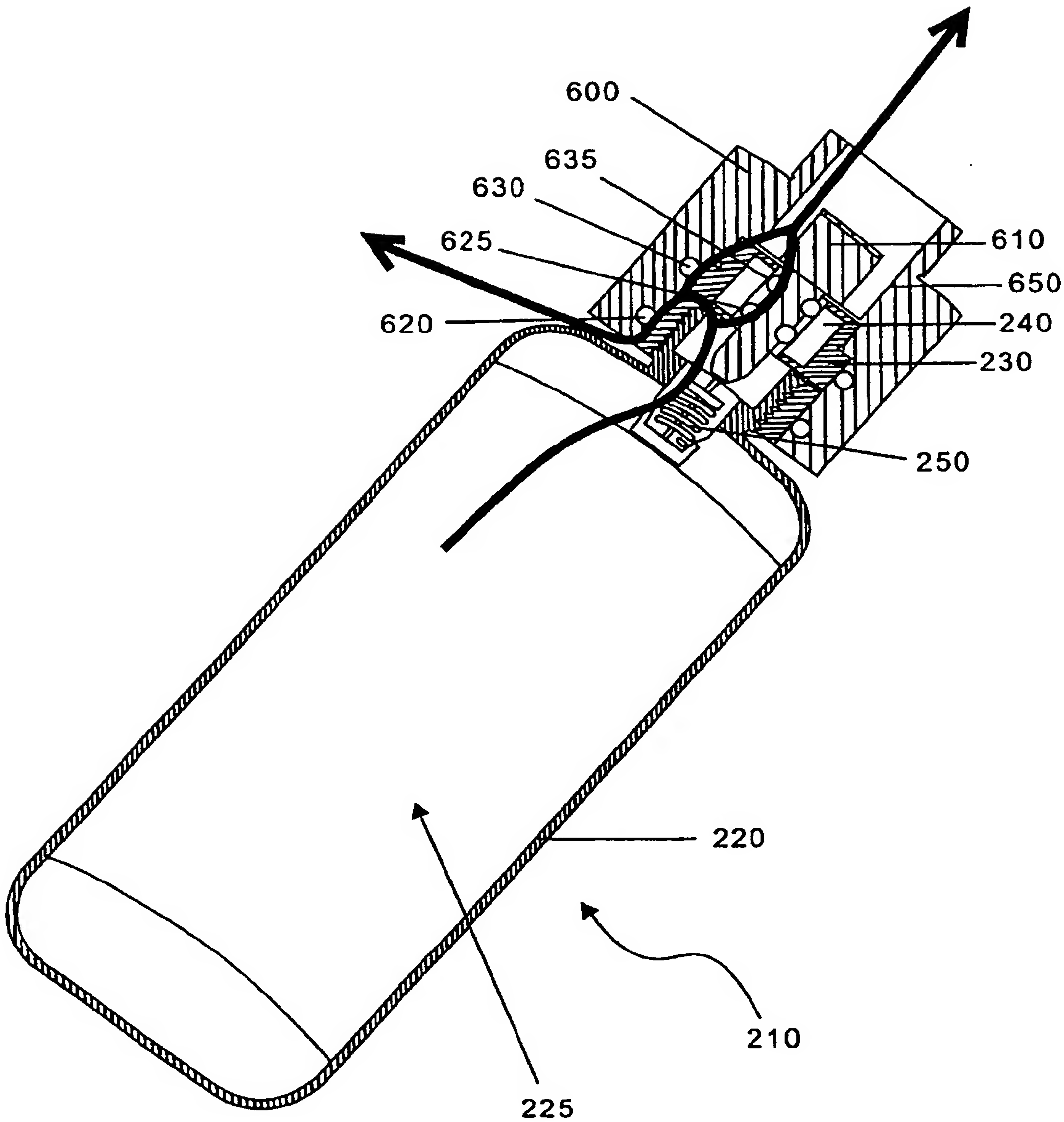

FIG. 7

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(54) Fuel container with integrated impurity removal cartridge, sulfur removal cartridge and method of reducing filter maintenance and making such a cartridge

(57) A fuel supply for a fuel cell including a fuel container (210) and an impurity removal cartridge (230) connected to the fuel container (210), where both the fuel container (210) and the impurity removal cartridge (230) are integrated into a single unit. Further independent claims are included for a sulfur removal cartridge (230) and a method of its manufacture as well as for a method of reducing filter maintenance in a fuel cell system.

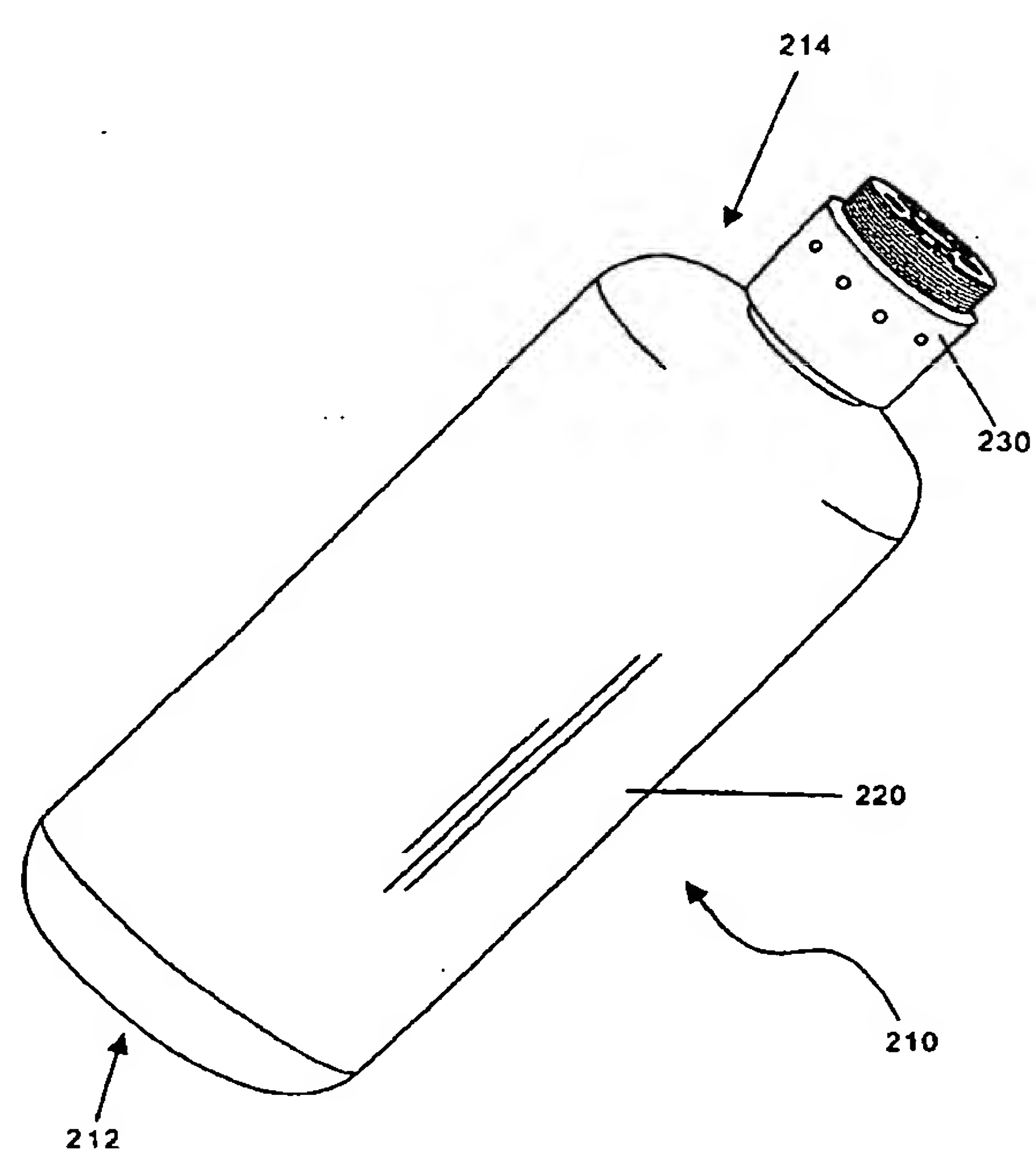

FIG. 2

EP 1 468 857 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 2911

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 4 522 159 A (ENGEL LARRY J ET AL) 11 June 1985 (1985-06-11) * column 20, line 61 - column 21, line 51; figures 9,10 * * column 17, lines 8-11 *	1,2,5,6, 9,10 3,4,7,8	B60K15/03 F17C1/00 H01M8/00 C01B3/50
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Y	DE 199 21 816 C (PEINE ANDRE ; STIMMING ULRICH (DE); STEFENER MANFRED (DE)) 26 October 2000 (2000-10-26) * column 2, lines 40-48 *	8	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B60K
F17C
H01M
C01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 August 2004	Plenk, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

Application Number
EP 03 02 2911

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ *Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):*

☐ *No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.*

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 03 02 2911

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-4,7-9

   fuel supply comprising a fuel container and an impurity removal cartridge as well as a fuel cell system and an electronic device comprising such a fuel supply

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2. claims: 5,6,10

   a sulfur/impurity removal cartridge and its method of manufacture

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 02 2911

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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31-08-2004

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